(12) UK Patent Application (19) GB (11) 2 315 622 (13) A

(43) Date of A Publication 04.02.1998

(21) Application No 9715566.7

(22) Date of Filing 23.07.1997

(30) Priority Data
(31) 08193186 (32) 23.07.1996 (33) JP

(71) Applicant(s)
NEC Corporation

(Incorporated in Japan)

7-1 Shiba 5-chome, Minato-ku, Tokyo 108-01, Japan

(72) Inventor(s)
Toru Matsuki

(74) Agent and/or Address for Service
Mathys & Squire
100 Grays Inn Road, LONDON, WC1X 8AL,
United Kingdom

(51) INT CL[6]
H04B 1/04 , H03G 3/20

(52) UK CL (Edition P)
H3G GCX G11E G8

(56) Documents Cited
None

(58) Field of Search
UK CL (Edition O) H3G GCX GPA GPE GPXX
INT CL[6] H03G 3/20 , H04B 1/04 1/74
ONLINE:WPI

(54) **Compensating for the failure of an amplifier in a transmitter by increasing the baseband signal**

(57) In a transmission device for use in a base station of a mobile communication system each of a predetermined number N of baseband signal producing sections produces a baseband signal from data signals. A baseband signal combining section 3 combines the baseband signals. Responsive to the combined baseband signal, a modulation circuit 4 modulates a carrier signal. A distributing circuit 7 distributes the modulation signal to a preselected number M of power amplifying circuits, respectively. Each power amplifying circuit amplifies the distributed modulation signal and produces an alarm signal when a failure occurs. A combining circuit 9 combines the amplified signals into the transmission signal. A control section controls the baseband signal producing sections in response to the alarm signal from each power amplifying circuit to increase a level of the combined baseband signal so as to compensate for a decrease in power of the transmission signal due to the failure occurred in a power amplifying circuit.

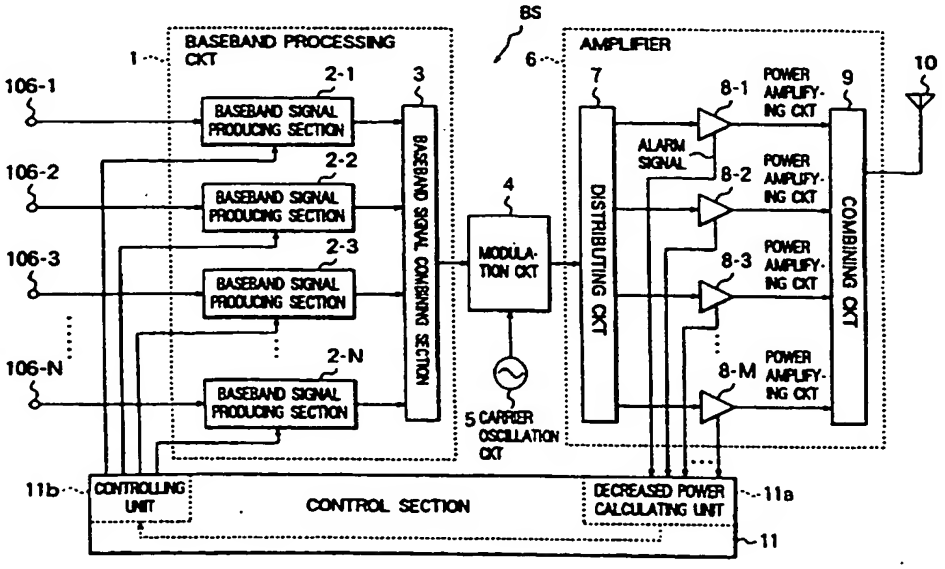

FIG. 2

GB 2 315 622 A

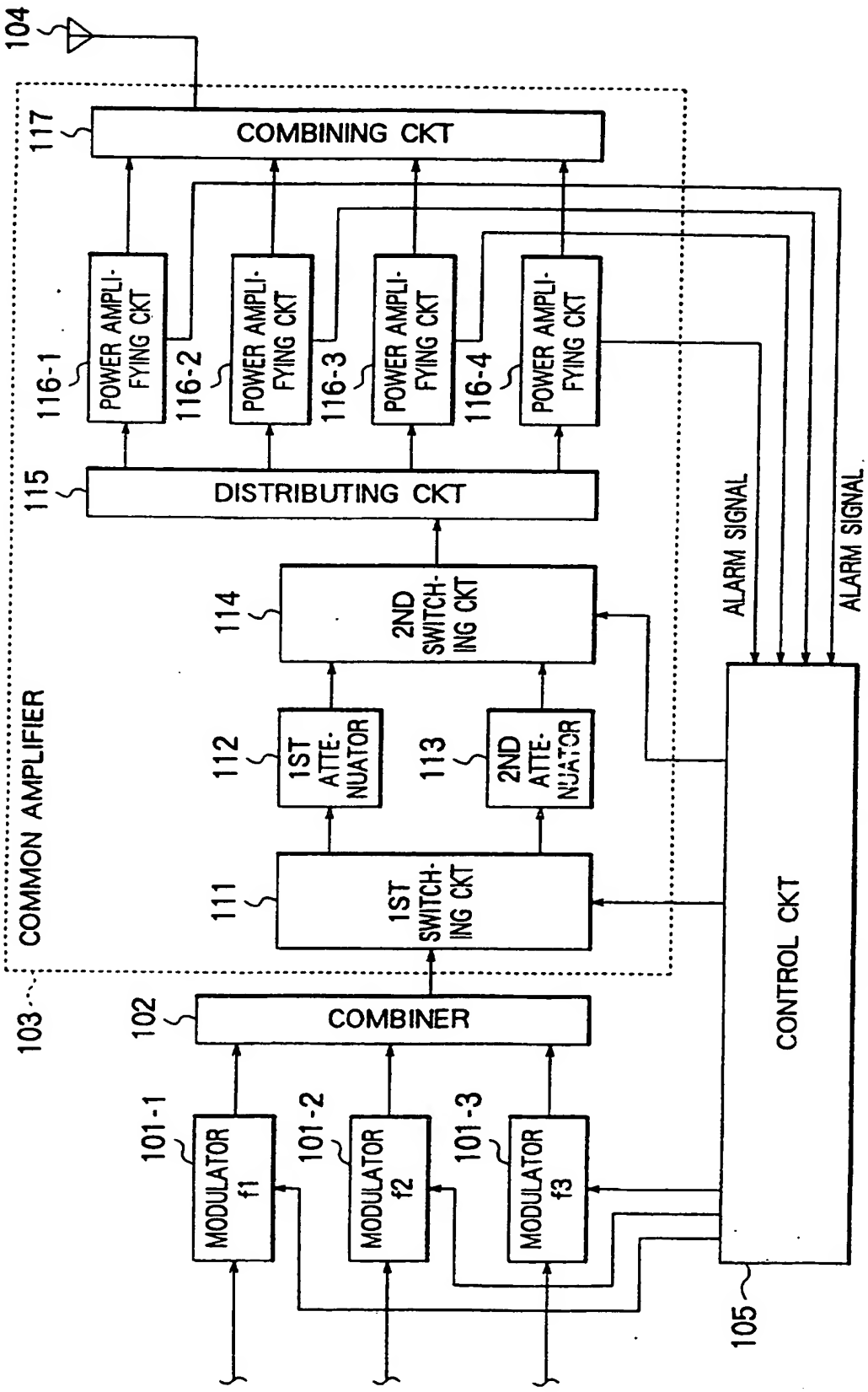

FIG. 1 PRIOR ART

BNSDOCID: <GB___2315622A__I_>

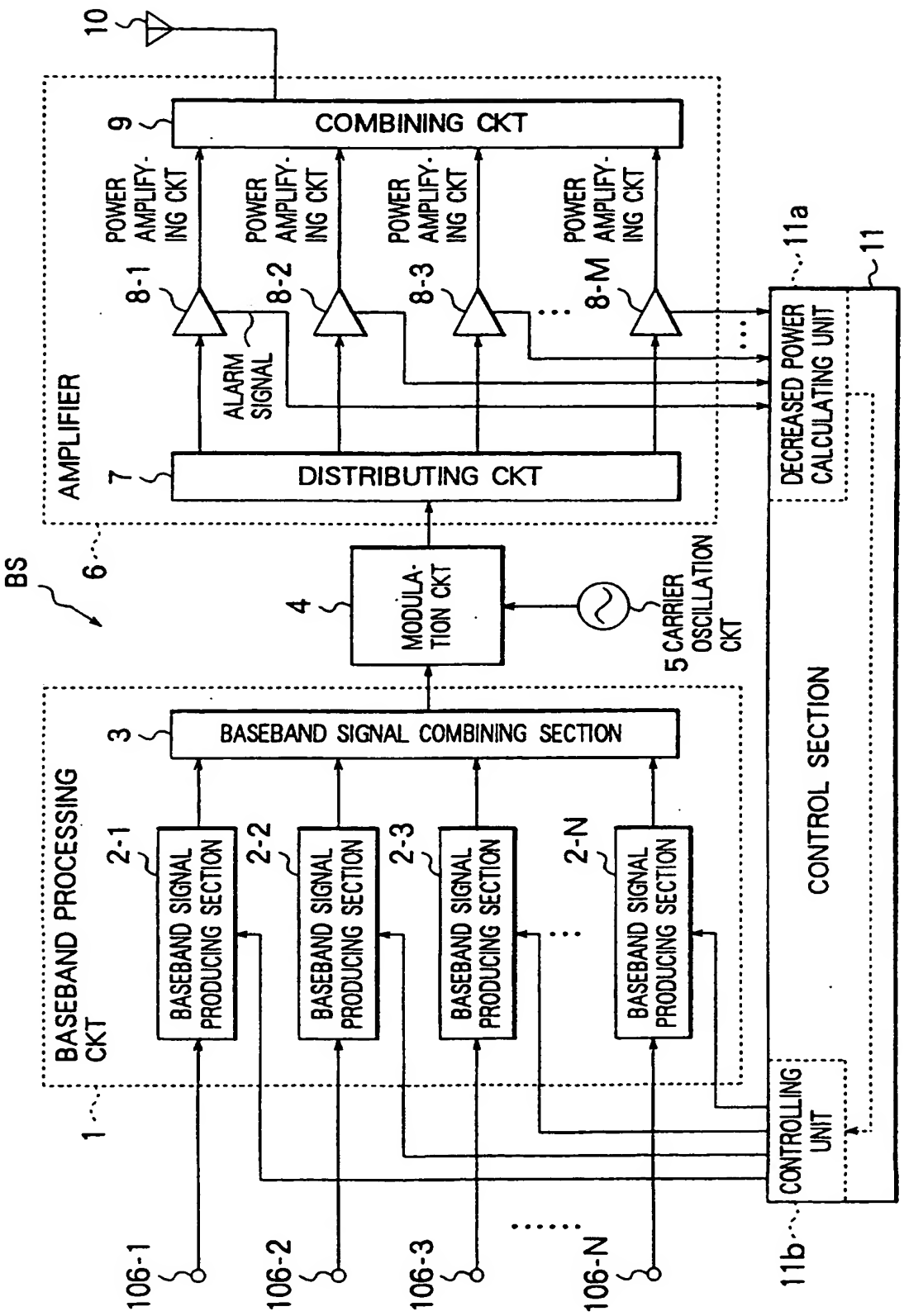
10
9
COMBINING CKT
POWER AMPLIFY-ING CKT
8-1
8-2
8-3
8-M
ALARM SIGNAL
AMPLIFIER
7
DISTRIBUTING CKT
6
BS
4
MODULA-TION CKT
5 CARRIER OSCILLATION CKT
11a
DECREASED POWER CALCULATING UNIT
11
3
BASEBAND SIGNAL COMBINING SECTION
BASEBAND PROCESSING CKT
2-1
2-2
2-3
2-N
BASEBAND SIGNAL PRODUCING SECTION
CONTROL SECTION
1
CONTROLLING UNIT
11b
106-1
106-2
106-3
106-N

FIG. 2

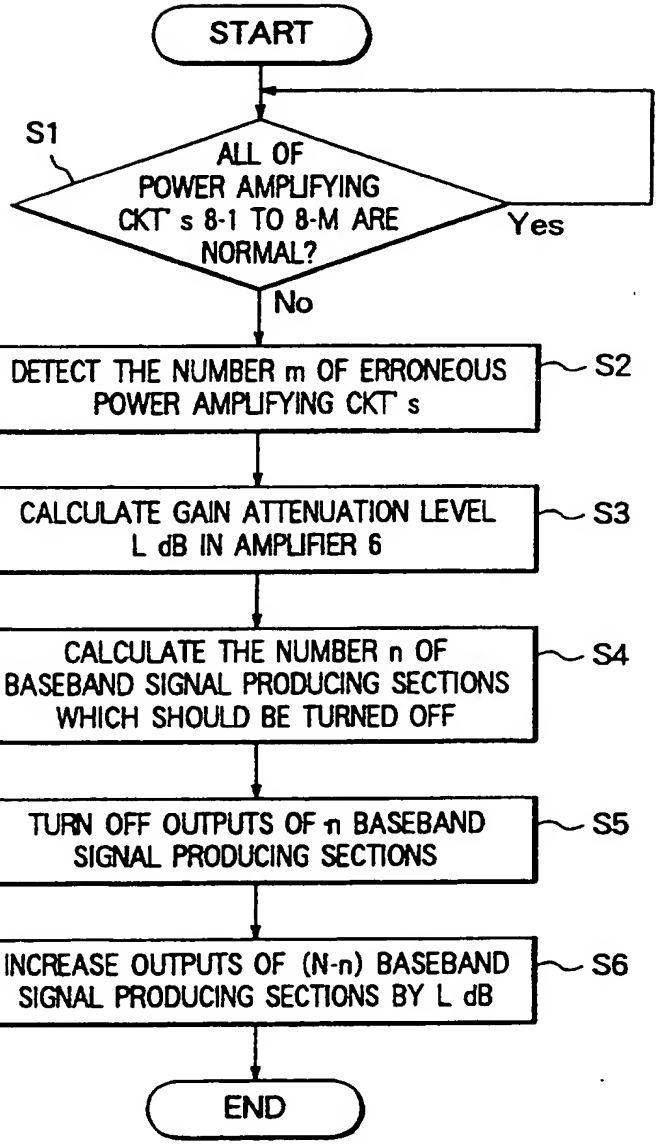

FIG. 3

BNSDOCID: <GB_ 2315622A_I >

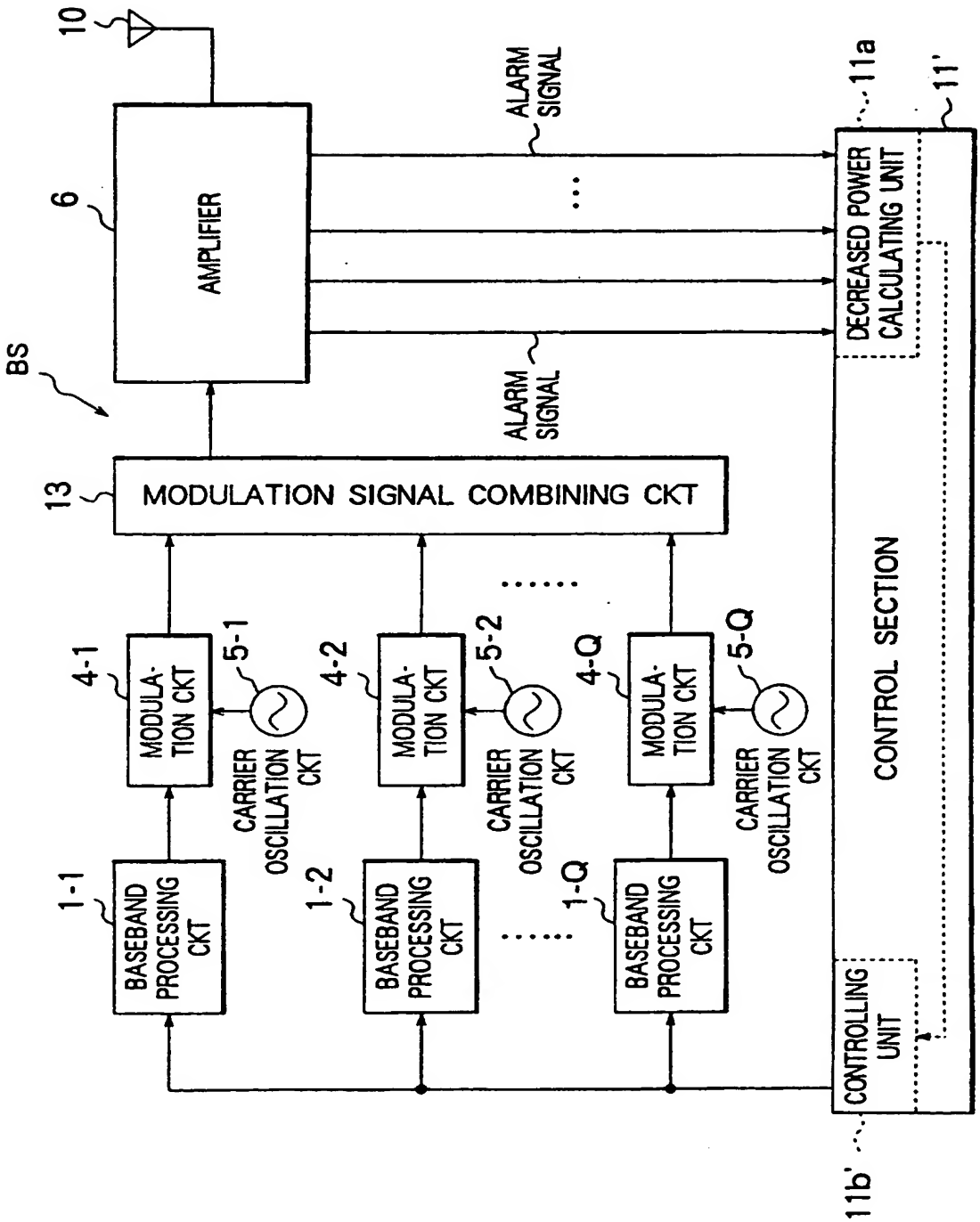
10
AMPLIFIER
6
BS
ALARM SIGNAL
ALARM SIGNAL
11a
11'
DECREASED POWER CALCULATING UNIT
13
MODULATION SIGNAL COMBINING CKT
4-1
MODULA-TION CKT
5-1
CARRIER OSCILLATION CKT
4-2
MODULA-TION CKT
5-2
CARRIER OSCILLATION CKT
4-Q
MODULA-TION CKT
5-Q
CARRIER OSCILLATION CKT
1-1
BASEBAND PROCESSING CKT
1-2
BASEBAND PROCESSING CKT
1-Q
BASEBAND PROCESSING CKT
CONTROL SECTION
CONTROLLING UNIT
11b'

FIG. 4

2315622

TRANSMISSION DEVICE WITH LOW POWER CONSUMPTION AND WITH A SMALL-SCALE CIRCUIT

Background of the Invention:

This invention relates to a transmission device for use in a base station of a mobile communication system.

A transmission device of the type described is for use in a base station of a mobile communication system in carrying out transmission of a transmission signal in response to a plurality of transmission data signals.

A conventional radio transmission device of the type may have a structure enabling simultaneous transmission of a plurality of radio frequencies and parallel amplification in a plurality of power amplifying circuits. With this structure, even in occurrence of a failure in at least one of the power amplifying circuits, transmission power is not decreased. In this manner, a service zone is prevented from being narrowed. For example, such a radio transmission device is disclosed in Japanese Unexamined Patent Publication (JP-A) No. 37651/1994.

As will later be described, the radio transmission device is, however, defective in that the

BNSDOCID: <GB___2315622A_I_>

device is large in its circuit scale and complicated in structure and that power consumption of the device inevitably large.

Summary of the Invention:

It is therefore an object of at least the preferred embodiments of this invention to provide a transmission device for use in a base station of a mobile communication system, which is operable with low power consumption and which has a small circuit scale.

Other objects of the preferred embodiments will become clear as the description proceeds.

In one aspect the invention provides a transmission device for transmitting a transmission signal in response to transmission data signals, comprising:

a baseband processing circuit comprising a plurality of baseband signal producing sections, for producing respective baseband signals by applying predetermined processing to input transmission data signals; and

a baseband signal combining section for combining the baseband signals into a combined baseband signal;

a carrier oscillation circuit for producing a carrier signal;

a modulation circuit for modulating said carrier signal in response to said combined baseband signal to produce a modulation signal;

an amplifier comprising a distributing circuit, a plurality of power amplifying circuits, and a combining circuit;

said distributing circuit distributing said modulation signal as respective distributed modulation signals to said power amplifying circuits;

each of said power amplifying circuits amplifying said distributed modulation signal to produce an amplified signal;

said combining circuit combining the amplified signals to produce said transmission signal; and

control means responsive to a failure of one or more of the power amplifying circuits for controlling the baseband signal producing sections to increase the level of the combined baseband signal so as to compensate for a decrease in the power of the transmission signal due to said failure.

Preferably the device is configured for use in a base station of a mobile communication system.

Thus, the transmission device may have input terminals, N in number, for receiving transmission data signals, respectively, where N represents an integer greater than one. The device carries out transmission of a transmission signal in response to the transmission data signals.

According to another aspect of this invention, the device comprises: a baseband processing circuit comprising baseband signal producing sections, N in number, connected to the input terminals, respectively, and a baseband signal combining section; a carrier oscillation circuit for producing a carrier signal; a modulation circuit; an amplifier comprising a distributing circuit, power amplifying circuits, M in number, and a combining circuit, where M represents another integer greater than

BNSDOCID: <GB 2315622A I >

one; and a control section. Each of the baseband signal producing sections produces, as a baseband signal, a processed signal given by subjecting a predetermined processing to the transmission data signal. The baseband signal combining section is connected to the baseband signal producing sections for combining the baseband signals into a combined signal. The modulation circuit is connected to the carrier oscillation circuit and the baseband signal combining section for modulating the carrier signal in response to the combined signal to produce a modulation signal. The distributing circuit is connected to the modulation circuit and to the power amplifying circuits for distributing the modulation signal into distributed modulation signals to deliver the distributed modulation signals to the power amplifying circuits, respectively. Each of the power amplifying circuits amplifies the distributed modulation signal to produce an amplified signal. Each of the power amplifying circuits produces an alarm signal when a failure occurs in each of the power amplifying circuits. The combining circuit is connected to the power amplifying circuits for combining the amplified signals to produce a combined signal as the transmission signal. The control section is connected to the power amplifying circuits and the baseband signal producing sections for controlling the baseband signal producing sections in response to the alarm signal from each of the power amplifying circuits to increase a level of the combined

signal so as to compensate for a decrease in power of the transmission singal due to the failure occurred in each of the power amplifying circuits.

A transmission device according to another aspect of this invention is for use in a base station of a mobile communication system in carrying out transmission of a transmission signal.

The device comprises: first through Q-th baseband processing circuits, each of which comprises baseband signal producing sections, N in number, and a baseband signal combining section, where Q represents an integer greater than one and where N representing another integer greater than one; first through Q-th carrier oscillation circuits for producing first through Q-th carrier signals of carrier frequencies different from each other, respectively; first through Q-th modulation circuits; a modulation signal combining circuit; an amplifier comprising a distributing circuit, power amplifying circuits, M in number, and a combining circuit, where M represents still another integer greater than one; and a control section. Each of the baseband signal producing sections of each of the first through the Q-th baseband processing circuits produces, as a baseband signal, a processed signal given by subjecting a predetermined processing to a transmission data signal. The baseband signal combining section of each of the first through the Q-th baseband processing circuits combines the baseband

BNSDOCID: <GB 2315622A I >

signals of the bas band signal producing sections of each of the first through th Q-th baseband processing circuits into a combined baseband signal. The first through the Q-th modulation circuits modulates the first through the Q-th carrier signals in response to the combined baseband signals of the baseband signal combining sections of the first through the Q-th baseband processing circuits to produce first through Q-th modulation signals, respectively. The modulation signal combining circuit combines the first through the Q-th modulation signals into a combined modulation signal. The distributing circuit of the amplifier distributes the combined modulation signal into distributed modulation signals to deliver the distributed modulation signals to the first through the M-th power amplifying circuits of the amplifier, respectively. Each of the power amplifying circuits amplifies the distributed modulation signal to produce an amplified signal. Each of the power amplifying circuits produces an alarm signal when a failure occurs in each of the power amplifying circuits. The combining circuit of the amplifier combines the amplified signals of the first through the M-th power amplifying circuits to produce the transmission signal. The control section controls the baseband signal producing sections of each of the first through the Q-th baseband processing circuits in response to the alarm signal from each of the power amplifying circuits to increase a level of the combined baseband signal of each

of the first through the Q-th baseband processing circuits so as to compensate for a decrease in power of the transmission signal due to the failure occurred in each of the power amplifying circuits.

Brief Description of the Drawing:

The invention will now be described merely by way of example with reference to the accompanying drawing wherein:

Fig. 1 is a block diagram of a conventional radio transmission device;

Fig. 2 is a block diagram of a transmission device according to a first embodiment of this invention;

Fig. 3 is a flow chart for describing operation of a control section in the transmission device illustrated in Fig. 2; and

Fig. 4 is a block diagram of a transmission device according to a second embodiment of this invention.

Description of the Preferred Embodiments:

Referring to Fig. 1, description will be made as regards a conventional radio transmission device for a better understanding of this invention. The radio transmission device is equivalent to the conventional radio transmission device which is described in the preamble of the instant specification and which is disclosed in the above-referred Japanese Unexamined Patent Publication (JP-A) No. 37651/1994.

The radio transmission device includes a plurality of modulators 101-1 through 101-3 each of which is supplied with an input signal, a combiner 102 for combining modulator outputs, a common amplifier 103 having a transmission antenna 104, and a control circuit

BNSDOCID: <GB__2315622A_I_>

105 for controlling modulation of the modulators 101-1 and 101-3 and a gain of the common amplifier 103.

The common amplifier 103 includes a first switching circuit 111, a first attenuator 112, a second attenuator 113, a second switching circuit 114, a distributing circuit 115, power amplifying circuits 116-1 through 116-4, and a combining circuit 117. The control circuits 105 produces control signals for use in controlling on/off of the modulator outputs of the modulators 101-1 through 101-3 and control signals for use in controlling switching of the first switching circuit 111 and the second switching circuit 114 in the common amplifier 103. In case of emergency such as the occurrence of a failure in each of the power amplifying circuits 116-1 through 116-4, the control circuit 105 is supplied as a feedback input with an alarm signal from each of the power amplifying circuits 116-1 through 116-4 in the common amplifier 103.

In the radio transmission device described above, the modulation signals are supplied to the modulators 101-1 through 101-3, respectively. In the modulators 101-1 through 101-3, carrier frequencies f1 through f3 are modulated by the input signals to produce modulation outputs, respectively. The modulation outputs are sent to the combiner 102. The combiner 102 produces a combined signal which is delivered to the common amplifier 103. The common amplifier 103 produces an amplifier output which is sent to the antenna 104.

Specifically, the output of the combiner 102 is d livered to the first switching circuit 111. The first switching circuit 111 selectively delivers the output to a selected one of the first attenuator 112 and the second attenuator 113. Either one of the output of the first attenuator 112 and the output of the second attenuator 113 is supplied to the second switching circuit 114. The second switching circuit 114 supplies a selected one of the outputs to the distributing circuit 115. The distributing circuit 115 distributes the output into four to be delivered to the power amplifying circuits 116-1 through 116-4, respectively. In a normal transmitting operation, the combined signal from the combiner 102 is selected by the first switching circuit 111 and delivered to the first attenuator 112. In this event, the first attenuator 112 attenuates the combined signal, for example, by Y1 dB. The power amplifying circuits 116-1 through 116-4 produces amplified outputs to be supplied to the combining circuit 117. The combining circuit 117 produces a combined transmission output to be delivered to the transmission antenna 104. As described above, each of the power amplifying circuits 116-1 through 116-4 produces the alarm signal when the failure occurs in each of the power amplifying circuits 116-1 through 116-4. The alarm signal serves to announce occurrence of the failur in any one of the power amplifying circuits 116-1 through 116-4.

BNSDOCID: <GB 2315622A I >

In the above-described radio transmission device, the common amplifier 103 produces an output of P (watts) per single frequency and delivers a transmission power of K x P (watts) when K radio frequencies are used. Each of the power amplifying circuits 116-1 through 116-4 produces the alarm signal when its gain becomes equal to or lower than a predetermined level. In case where the failure occurs in any one of the power amplifying circuits 116-1 through 116-4 and its amplified output is turned off, the combining circuit 117 produces a loss X dB which decreases the combined transmission power. At this time, the control circuit 105 controls the first switching circuit 111 and the second switching circuit 114 to make the combined signals from the combiner 102 pass through the second attenuator 113. The second attenuator 113 has an attenuation level Y2 dB smaller than the attenuation level Y1 dB of the first attenuator 112. As a result, the distributor 115 is supplied with an input level which is increased by (Y2 - Y1) dB. Under the condition selected so that the relationship represented by X = Y1 - Y2 is held, the combined transmission output from the combining circuit 117 is kept unchanged so that the transmission power of a prescribed level is delivered from the transmission antenna 104.

In the above-mentioned condition, however, the distributed input signal level supplied to each of the power amplifying circuits 116-1 through 116-4 is

increased. This may result in an increas of the intermodulation distortion in the power amplifying circuits 116-1 through 116-4. Therefore, the control circuit 105 controls any of the modulators 101-1 through 101-3 to stop the modulation output in order to decrease the number of the input frequencies supplied to the common amplifier 103. For example, the control circuit 105 carries out control so that the relationship given by $X = 10 \times \log(K/R)$ is held, where R represents the number of radio frequencies to be used after occurrence of the failure in any of the power amplifying circuits 116-1 through 116-4.

There are various known techniques related to such a communication system comprising amplifying sections in a parallel operation arrangement and having an alarm producing function. For example, Japanese Unexamined Patent Publication (JP-A) No. 169442/1981 discloses a parallel operation circuit of a heterodyne repeater. Japanese Patent Publication (JP-B) No. 48702/1991 discloses an automatic gain control device for a television relay broadcasting device with parallel operation power amplifiers. Japanese Unexamined Patent Publication (JP-A) No. 304429/1993 discloses parallel operation amplifiers and a failure detecting circuit therefor.

In order to keep the antenna output constant upon occurrence of the failure in the power amplifying circuit, the above-described radio transmission device

BNSDOCID: <GB 2315622A_1_>

has a structure such that the attenuation level of the carrier modulation signals is variable by the use of a plurality of the switching circuits and the attenuation circuits to which the combined signal of the carrier modulation signals is supplied. Furthermore, in order to enable the attenuation level to be variable when the carrier modulation signal has a frequency on the order of several hundreds MHz or more, switching units or attenuators of a coaxial type must be used as the switching circuit and the attenuation circuit, respectively. This results in a disadvantage that the device is large in its entire scale and complicated in structure.

Moreover, even when all of the power amplifying circuits are normally operated, it is necessary to keep a high output power of each modulator in preparation for the failure in the power amplifying circuits. Specifically, even in the normal state, the modulator output should be increased by (Y1 dB + attenuation through the first switching circuit + attenuation through the second switching circuit) dB. This brings about a corresponding increase in power consumption of the modulator. As a result, the power consumption of the device inevitably becomes large.

The embodiment of the invention now described provides a transmission device for use in a base station of a mobile communication system, which is operable with a low power consumption and which has a small circuit scale.

Turning to Fig. 2, description will proceed to a transmission device according to a first embodiment of this invention. The transmission device is for use in a base station BS of a mobile communication system including mobile stations (not shown) which communicate with the base station BS. The transmission device has first through N-th input terminals 106-1 to 106-N for receiving transmission data signals, respectively, where N represents an integer greater than one. The transmission device carries out transmission of a transmission signal through a transmission antenna 10 to the mobile stations in response to the transmission data signals.

The transmission device includes a baseband processing circuit 1 which has first through N-th baseband signal producing sections 2-1 to 2-N connected to the input terminals 106-1 to 106-N, respectively, and a baseband signal combining section 3. The transmission device further includes a carrier oscillation circuit 5 for producing a carrier signal having a radio channel frequency of, for example, 800MHz, a modulation circuit4, an amplifier 6, and a control section 11. The amplifier 6 includes a distributing circuit7, first through M-th power amplifying circuits 8-1 to 8-M, and a combining circuit 9, where M represents another integer greater than one.

Each of the baseband signal producing sections 2 (suffixes omitted) produces, as a baseband signal, a

BNSDOCID: <GB___2315622A_I_>

processed signal given by subjecting a pred termined processing to the transmission data signal. The predetermined processing is typically a coding processing. On carrying out the coding processing, each of the baseband signal producing sections 2 produces, as the baseband signal, a coded signal given by coding the transmission data signal. The coding processing further includes addition of error correction codes, interleave, addition of patterns required upon communication, and signal processing adapted to a modulation system of the modulation circuit 4. Alternatively, the predetermined processing is a spread spectrum processing. In this case, each of the baseband signal producing sections 2 produces, as the baseband signal, the processed signal given by subjecting, as the predetermined processing, the spread spectrum processing to the transmission data signal. That is, the baseband signal producing sections 2 carry out the spread spectrum processing on the transmission data signals on the basis of the spreading codes, respectively, which are different from one another.

Connected to the baseband signal producing sections 2, the baseband signal combining section 3 combines the baseband signals into a combined baseband signal.

The modulation circuit 4 is connected to the carrier oscillation circuit 5 and the baseband signal combining section 3 and modulates the carrier signal in

response to the combined baseband signal to produce a modulation signal.

The distributing circuit 7 is connected to the modulation circuit 4 and to the power amplifying circuits 8 (suffixes omitted) and distributes the modulation signal into distributed modulation signals to deliver the distributed modulation signals to the power amplifying circuits 8, respectively.

Each of the power amplifying circuits 8 amplifies the distributed modulation signal to produce an amplified signal. Each of the power amplifying circuits 8 further produces an alarm signal when a failure occurs in each of the power amplifying circuits 8. Each of the power amplifying circuits 8 detects the failure to produce the alarm signal when a gain of each of the power amplifying circuits 8 is equal to or lower than a predetermined value as a result of comparison of a power of the distributed modulation signal supplied thereto with another power of the amplified signal supplied therefrom. For example, the predetermined value of the gain at which the alarm signal is produced due to decrease of a measured gain is selected to be equal to or lower than 50% of the gain in a normal state of each of the power amplifying circuits 8.

Connected to the power amplifying circuits 8, the combining circuit 9 combin s the amplified signals to produces the transmission signal.

BNSDOCID: <GB 2315622A I >

The control section 11 is connected to the power amplifying circuits 8 and the baseband signal producing sections 2. The control section 11 controls the baseband signal producing sections 2 in response to the alarm signal from each of the power amplifying circuits 8 to increase a level (or an amplitude) of the combined baseband signal so as to compensate for a decrease in power of the transmission singal due to the failure occurred in each of the power amplifying circuits 8. For this purpose, the control section 11 delivers to each of the baseband signal producing sections 2 a control signal for controlling an amplitude of the baseband signal.

The control section 11 includes a decreased power calculating unit 11a and a controlling unit 11b. The decreased power calculating unit 11a is connected to the power amplifying circuits 8 and calculates as a decreased power, in response to the alarm signal from each of the power amplifying circuits 8, the decrease in power of the transmission singal due to the failure occurred in each of the power amplifying circuits 8. The controlling unit 11b is connected to the decreased power calculating unit 11a and the baseband signal producing sections 2 and controls the baseband signal producing sections 2 to increase the level of the combined baseband signal so as to compensate for the decreased power.

The decreased power calculating unit 11a includes a detecting part which carries out steps S1 and S2 (later described) in Fig. 3. The detecting part (S1 and S2) is

connected to the power amplifying circuits 8 and detects, in response to the alarm signal from each of the power amplifying circuits 8, the number m of erroneous power amplifying circuits in which the failure occurs among the power amplifying circuits 8.

The decreased power calculating unit 11a further includes a calculating part which carries out a step S3 (later described) in Fig. 3. The calculating part (S3) is connected to the detecting part (S1 and S2) and calculates the decreased power in response to the number m of the erroneous power amplifying circuits.

The controlling unit 11b includes a calculating part which carries out a step S4 (later described) in Fig. 3. The calculating part (S4) is connected to the decreased power calculating unit 11a and calculates, in response to the decreased power by the use of a relationship represented by $10 \times \log(n \times p) = 10 \times \log(N \times p) - L$, the number n of baseband signal producing sections which should be turned off among the N baseband signal producing sections 2, where the deceased power is represented by L (dB) and where each of the power amplifying circuits produces the amplified signal p(W) when each of the power amplifying circuits 8 is normally operated without occurrence of the failure.

The controlling unit 11b further includes a turning-off part which carries out a step S5 (later described) in Fig. 3. The turning-off part (S5) is connected to the calculating part (S4) and turns off n

BNSDOCID: <GB 2315622A_ I >

baseband signal producing sections among the N baseband signal producing sections 2.

The controlling unit 11b still further includes an increasing part which carries out a step S6 (later described) in Fig. 3. The increasing part (S6) is connected to the turning-off part (S5) and increases each of output levels of (N - n) remaining baseband signal producing sections so that the level of the combined baseband signal is increased by L (dB).

Thus, the control section 11 restricts the number of available ones of the baseband signal producing sections 2 in order to suppress an increase of the modulation signal of the modulation circuit 4 within a range such that intermodulation distortion of the power amplifying circuits normally operated without occurrence of the failure is not deteriorated.

Each of the baseband signal producing sections 2 has functions of varying the amplitude of the baseband signal and turning off the production of the baseband signal in response to the control signal supplied from the control section 11. This function of varying the amplitude of the baseband signal for each transmission data signal makes it possible to vary the input power of each transmission data signal supplied to the amplifier 6.

As the gain of the amplifier 6 in the normal state is constant, the output power of each transmission data signal delivered from the transmission antenna 10

can be varied. For example, when the output of the baseband signal producing section 2-1 is increased to twice in terms of the power level, the input supplied to the amplifier 6 increases by 3dB. As a result, the output power modulated by the output of the baseband signal producing section 2-1 will be increased by 3dB at the output of the transmission antenna 10.

The baseband signal producing sections 2 are implemented by digital signal processing, such as DSP (digital signal processor) or ASIC. On the other hand, the baseband signal combining section 3 is implemented by digital signal processing such as DSP or ASIC. When the modulation circuit 4 adopts orthogonal modulation as the modulation system, the baseband signal combining section 3 delivers the combined baseband signal having an I component and a Q component to the modulation circuit 4.

The amplifier 6 outputs P(W) per one transmission data signal, and outputs P x N (W) when the transmission data signals, N in number, are used. The amplifier 6 is excellent in linearity to suppress the distortion in output down to a predetermined level or less, and has low power consumption. Specifically, the amplifier has a structure such that the M power amplifying circuits 8, operated in parallel, and has a function such that the phase characteristic of the modulation signal passing through each circuit is made to coincide with a sp cific value within a predetermined range. With the abov - mentioned function of the power amplifying circuits 8,

BNSDOCID: <GB 2315622A 1 >

the distributing circuit 7, and the combining circuit 9, it is possible to produce the transmission signal having a reduced loss so that low power consumption is achieved. The distributing circuit 7 or the combining circuit 9 can be implemented, for example, by a Wilkinson distributing circuit or a Wilkinson combining circuit.

In the transmission device for use in a mobile communication system, it is assumed that, when the power amplifying circuits 8 are normally operated, each of the baseband signal producing sections 2 has output power p (W), the amplifier 6 has a gain G (dB), and the modulation circuit 4 has a gain g (dB) in order to keep the transmission power of P (W) per one transmission data signal. Herein, the relationship given by $G = 10 \times \log(P/p) - g$ is held.

Turning to Fig. 3, description will proceed to operation of the control section 11 of Fig. 2. At first, the control section 11 judges whether or not the power amplifying circuits 8-1 to 8-M are normal (step S1). If the result shown they are normal, the operation returns to the upstream of the judging step (step S1) to continuously monitor the power amplifying circuits 8-1 to 8-M.

On the other hand, unless they are normal, it is indicated that an error occurs in any of the power amplifying circuits 8-1 to 8M. Then, detection is made of the number m of erroneous ones of the power amplifying circuits 8-1 to 8-M (step S2). Thereafter, calculation

is mad of a gain attenuation level L dB in the amplifier 6, which l vel is uniquely determined by the number m of the erroneous power amplifying circuits (step S3).

Subsequently, the control section 11 calculates, as the number uniquely determined by the gain attenuation level L dB of the amplifier 6, the number n of those baseband signal producing sections whose outputs should be turned off (step S4). Then, the outputs of the n baseband signal producing sections are turned off (step S5).

The number n of those baseband signal producing sections whose outputs should be turned off can be calculated by the use of the relationship represented by $10 \times \log(n \times p) = 10 \times \log(N \times p) - L$. In the control operation of turning off the outputs of the n baseband signal producing sections (step S5), particular ones of the baseband signal producing sections which are not supplied with any transmission data signal are preferentially turned off. It is supposed that the number of the baseband signal producing sections without any transmission data signal supplied thereto is less than n. In this event, the control operation is carried out in such a manner that the outputs are successively turned off from those baseband signal producing sections to which the input of the transmission data signals has been finished. The abov -mentioned control operation serves to prevent the transmission data signal in use from being forcedly interrupted.

BNSDOCID: <GB___2315622A__I_>

After the step of turning off the outputs of the n baseband signal producing sections (step S5), the outputs of the remaining baseband signal producing sections (N - n), in number, except the baseband signal producing sections having been turned off in the preceding step are increased by L dB (step S6). By this operation, the transmission power of the output signals produced form the (N - n) baseband signal producing sections is kept unchanged at P(W) which is the output power delivered from the transmission antenna 10 before the failure occurs in the m power amplifier circuits.

As described above, in the transmission device for use in a mobile communication system illustrated in Fig. 1, it is possible to compensate, by increasing the outputs of the baseband signal producing sections by L dB, the decrease L dB of the transmission power caused by the attenuation in gain of the amplifier 6 when the m power amplifier circuits are failed.

When four power amplifying circuits 8-1 to 8-4 are normal in the above-described transmission device for use in a mobile communication system each of the sixteen baseband signal producing sections 2-1 to 2-16 has output power of 0.1(W), the amplifier 6 has a gain of 10 (dB), and the modulation circuit 4 has a gain of 0 (dB) so as to keep the transmission power 1 (W) per one transmission data signal. In this event, the control section 11 judges whether or not the power amplifying circuits 8-1 to 8-4 are normal and, in case of occurrence of an error

in any one of the power amplifying circuits 8-1 to 8-4, detects th number of the rroneous ones of the power amplifying circuits 8-1 to 8-4.

It is supposed here that the power amplifying circuit 8-1 is failed. Then, calculation is made of the gain attenuation level L dB of the amplifier 6 caused by the failure in the single power amplifier circuit 8-1 (herein, L dB = 3 dB). The control section 11 calculated, as the number uniquely determined by the gain attenuation level L dB of the amplifier 6, the number n of those baseband signal producing sections whose outputs should be turned off. Then the outputs of then baseband signal producing sections are turned off. Thus, the gain attenuation level of 3 dB is caused in the amplifier 6 due to the failure in the single power amplifying circuit 8-1. On the other hand, the number of baseband signal producing sections 2-1 through 2-16 is equal to sixteen. In this event, the number n of those baseband signal producing sections whose outputs should be turned off is equal to eight.

In the control operation of turning off the outputs of the eight baseband signal producing sections, particular ones of the baseband signal producing sections which are not supplied with any transmission data signal are preferentially turned off. It is supplied that the number of the baseband signal producing sections without any transmission data signal supplied thereto is less than eight. In this event, the control op ration is

BNSDOCID: <GB__2315622A__I_>

carried out in such a manner that the outputs are succ ssively turn d off from those baseband signal producing sections to which the input of the transmission data signals has been finished. The above-mentioned operation is continued until the number of the baseband signal producing section whose outputs of the baseband signals have been turned off is counted up to eight.

After the outputs of the eight baseband signal producing sections are turned off, the control section 11 increases, by L dB, the outputs of the (N - n) baseband signal producing sections except the baseband signals producing sections which have been turned off. Herein, eight (16 - 8) baseband signals producing sections are operable. The outputs of these eight baseband signal producing sections are increased by 3 dB corresponding to 0.2 (W).

By this operation, the transmission power of the output signals produced from the eight baseband signal producing sections is kept unchanged at 1 (W) which is the output power delivered from the transmission antenna 10 before the failure occurs in the single power amplifier circuit 8A. This means that the increase of the outputs of the baseband signal producing sections by 3 dB can compensate the decrease 3 dB of the transmission power caused by the gain attenuation in the amplifier 6 when th single power amplifier circuit 8A is failed.

Turning to Fig. 4, description will proceed to a transmission device according to a second embodiment of

this invention. Th transmission device is also for use in a base station BS of the mobile communication system in carrying out transmission of a transmission signal through a transmission antenna 10 to mobile stations (not shown) like the transmission device illustrated in Fig. 2.

The transmission device includes first through Q-th baseband processing circuits 1-1 to 1-Q, where Q represents an integer greater than one. Each of the first through the Q-th baseband processing circuits 1-1 to 1-Q is similar in structure to the baseband processing circuit 1 of the transmission device illustrated in Fig. 2. That is, each of the first through the Q-th baseband processing circuits 1-1 to 1-Q includes baseband signal producing sections 2-1 to 2-N (Fig. 2) and a baseband signal combining section3 (Fig. 2), where N representing another integer greater than one.

The transmission device further includes first through Q-th carrier oscillation circuits 5-1 to 5-Q which produces first through Q-th carrier signals of carrier frequencies f1 to fQ different from each other, respectively. The transmission device still further includes first through Q-th modulation circuits 4-1 to 4-Q, a modulation signal combining circuit 13, an amplifier 6, and a control section 11'.

The amplifier 6 is similar in structure to the amplifier 6 of the transmission device illustrated in Fig. 2. That is, the amplifier 6 includes a distributing

BNSDOCID: <GB__2315622A_I_>

circuit 7 (Fig. 2), first through M-th power amplifying circuits 8-1 to 8-M (Fig. 2), and a combining circuit 9, where M represents still another integer greater than one.

Each of the baseband signal producing sections 2-1 to 2-N of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q produces, as a baseband signal, a processed signal given by subjecting a predetermined processing to a transmission data signal which is described above in Fig. 2. The predetermined processing is typically a coding processing for coding the transmission data signal to produce a coded signal as the baseband signal in the manner which is described above.

The baseband signal combining section 3 of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q combines the baseband signals of the baseband signal producing sections 2-1 to 2-N of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q into a combined baseband signal.

The first through the Q-th modulation circuits 4-1 to 4-Q modulates the first through the Q-th carrier signals in response to the combined baseband signals of the baseband signal combining sections 3 of the first through the Q-th baseband processing circuits 1-1 to 1-Q to produce first through Q-th modulation signals, r spectively.

The modulation signal combining circuit 13 combines the first through the Q-th modulation signals into a combined modulation signal.

The distributing circuit 7 of the amplifier 6 distributes the combined modulation signal into distributed modulation signals to deliver the distributed modulation signals to the first through the M-th power amplifying circuits 8-1 to 8-M of the amplifier 6, respectively.

Each of the power amplifying circuits 8-1 to 8-M amplifies the distributed modulation signal to produce an amplified signal. Each of the power amplifying circuits 8-1 to 8-M produces an alarm signal when a failure occurs in each of the power amplifying circuits 8-1 to 8-M in the manner described above.

The combining circuit 9 of the amplifier 6 combines the amplified signals of the first through the M-th power amplifying circuits 8-1 to 8-M to produce the transmission signal.

The control section 11' controls the baseband signal producing sections 2-1 to 2-N of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q in response to the alarm signal from each of the power amplifying circuits 8-1 to 8-M to increase a level of the combined baseband signal of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q so as to compensate for a decrease in power of the transmission singal due to the failure occurr d in ach of the power

BNSDOCID: <GB 2315622A I >

amplifying circuits 8-1 to 8-M.

Th control s ction 11' includes a decreased power calculating unit 11a and a controlling unit 11b'. The decreased power calculating unit 11 is connected to the power amplifying circuits 8-1 to 8-M and calculates as a decreased power, in response to the alarm signal from each of the power amplifying circuits 8-1 to 8-M, the decrease in power of the transmission singal due to the failure occurred in each of the power amplifying circuits 8-1 to 8-M. The controlling unit 11b' is connected to the decreased power calculating unit 11a and the baseband signal producing sections 2-1 to 2-N of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q and controls the baseband signal producing sections 2-1 to 2-N of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q to increase the level of the combined baseband signal of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q so as to compensate for the decreased power.

The decreased power calculating unit 11a includes a detecting part which carries out the above-mentioned steps S1and S2 of Fig. 3. For this purpose, the detecting part (S1 and S2) is connected to the power amplifying circuits 8-1 to 8-M and detects, in response to the alarm signal from each of the pow r amplifying circuits 8-1 to 8-M, the number m of erroneous power amplifying circuits in which the failure occurs among the

power amplifying circuits 8-1 to 8-M.

The decr ased pow r calculating unit 11a further includes a calculating part which carries out the step S3 of Fig. 3. For this purpose, the calculating part (S3) is connected to the detecting part (S1 and S2) and calculates the decreased power in response to the number m of the erroneous power amplifying circuits.

The controlling unit 11' includes a calculating part which carries out the step S4 of Fig. 3. For this purpose, the calculating part (S4) is connected to the decreased power calculating unit 11a and calculates, in response to the decreased power by the use of a relationship represented by 10 x log(n x p) = 10 x log(N x p) - L, the number n of baseband signal producing sections which should be turned off among the N baseband signal producing sections 2-1 to 2-N of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q, where the deceased power is represented by L (dB) and where each of the power amplifying circuits 8-1 to 8-M produces the amplified signal p(W) when each of the power amplifying circuits 8-1 to 8-M is normally operated without occurrence of the failure.

The controlling unit 11' further includes a turning-off part which carries out the step S5 of Fig. 3. For this purpose, the turning-off part (S5) is connected to the calculating part (S4)and turns off n baseband signal producing sections among the N baseband signal producing sections 2-1 to 2-N of ach of the first

BNSDOCID: <GB___2315622A__I_>

through the Q-th baseband processing circuits 1-1 to 1-Q.

The controlling unit 11' still further includes an increasing part which carries out the step S6 of Fig. 3. For this purpose, the increasing part (S6) is connected to the turning-off part (S5) and increases each of output levels of (N - n) remaining baseband signal producing sections of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q so that the level of the combined baseband signal of each of the first through the Q-th baseband processing circuits 1-1 to 1-Q is increased by L (dB).

In this manner, the control section 11b' restricts the number of available ones of the baseband singal producing sections 2-1 to 2-N in order to suppress an increase of the combined modulation signal of the modulation signal combining circuit 13 within a range such that intermodulation distortion of the power amplifying circuits normally operated without occurrence of the failure is not deteriorated.

In the transmission device of Fig. 4, the carrier oscillation circuits 5-1 to 5-Q have functions of oscillating different carrier frequencies f1 to fQ. Thus, a plurality of frequencies are used as channel frequencies.

In the above-mentioned transmission device according to this invention, th amplifier compris s a plurality of the power amplification circuits to carry out parallel amplification. Controlled by the control

section, the baseband processing circuit is operated so that a transmission power of the transmission signal is not decreased even in occurrence of a failure in at least one of the power amplifying circuits. Thus, a service zone is prevented from being narrowed.

More specifically, in case of occurrence of the failure in at least one of the power amplifying circuits, the gain of the amplifier decreases. The decrease of the gain implies the decrease of the transmission power, which causes the service zone to become narrow. In order to prevent the above, the control section controls the baseband processing circuit so as to increase the input power supplied to the amplifier. Specifically, as the input power supplied to the amplifier is proportional to the output power of the baseband signal producing sections of the baseband processing circuit, it is possible to prevent the service zone from being narrowed by increasing the output power of the baseband signal producing sections.

However, the increase of the input power may deteriorate the intermodulation distortion characteristics of the power amplifying circuits. This results in deterioration of the communication quality. In view of the above, in order to prevent the increase of the intermodulation distortion and to avoid the service zone from b ing narrowed, the control section controllably restricts the number of the available ones of the baseband signal producing sections in the baseband

BNSDOCID: <GB 2315622A I >

processing circuit. In this manner, the total sum of the modulation signal power supplied to the power amplifying circuits is kept at a level not higher than the predetermined level. Thus, by restricting the number of the baseband signal producing sections, the output power per one baseband signal producing section is increased and the increase of the input supplied to the power amplifier is reduced. As a result, the intermodulation distortion characteristic of the power amplifying circuit is prevented from deterioration.

As described above, in the transmission device according to this invention, in occurrence of the failure in at least one of the power amplifying circuits, the baseband processing circuit controlled by the control section is operable to increase the input power supplied to the amplifier which includes a plurality of the power amplification circuits arranged to carry out parallel amplification. With this structure, the transmission power of the transmission signal is not decreased even in occurrence of the failure in at least one of the power amplifying circuits. Thus, the service zone is prevented from being narrowed. This enables the operation with a small-scale circuit structure and low power consumption. In addition, this invention is applicable not only to a transmission device adopting a spread spectrum communication system in which a plurality of transmission data signals are transmitted by the use of a single

frequency but also to a radio transmission device for simultaneously transmitting a plurality of frequencies.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

The text of the abstract filed herewith is repeated here as part of the specification.

In a transmission device for use in a base station of a mobile communication system in carrying out transmission of a transmission signal, each of a predetermined number N of baseband signal producing sections produces a baseband signal given by subjecting a predetermined processing to a transmission data signal. A baseband signal combining section combines the baseband signals of all baseband signal producing sections into combined baseband signal. Responsive to the combined baseband signal, a modulation circuit modulates a carrier signal of a carrier oscillation circuit into a modulation signal. A distributing circuit distributes the signal into distributed modulation signals to deliver the distributed modulation signals to a preselected number M of power of amplifying circuits, respectively. Each power amplifying circuit amplifies the distributed modulation signal as an amplified signal and produced an alarm signal when a failure occurs. A combining circuit combines the amplified signals of all power amplifying circuits into the transmission signal. A control section controls the baseband signal producing sections in response to the alarm signal from each power amplifying circuit to increase a level of the combined baseband signal so as to compensate for a decrease in power of the transmission signal due to the failure occurred in each power amplifying circuit.

BNSDOCID: <GB___2315622A _I >

CLAIMS

1. A transmission device for transmitting a transmission signal in response to transmission data signals, comprising:

a baseband processing circuit comprising a plurality of baseband signal producing sections, for producing respective baseband signals by applying predetermined processing to input transmission data signals; and

a baseband signal combining section for combining the baseband signals into a combined baseband signal;

a carrier oscillation circuit for producing a carrier signal;

a modulation circuit for modulating said carrier signal in response to said combined baseband signal to produce a modulation signal;

an amplifier comprising a distributing circuit, a plurality of power amplifying circuits, and a combining circuit;

said distributing circuit distributing said modulation signal as respective distributed modulation signals to said power amplifying circuits;

each of said power amplifying circuits amplifying said distributed modulation signal to produce an amplified signal;

said combining circuit combining the amplified signals to produce said transmission signal; and

control means responsive to a failure of one or more of the power amplifying circuits for controlling the baseband signal producing sections to increase the level of the combined baseband signal so as to compensate for a decrease in the power of the transmission signal due to said failure.

2. A transmission device as claimed in claim 1 being configured for use in a base station of a mobile communication system.

3. A transmission device which is for use in a base station of a mobile communication system and which has input terminals, N in number, for receiving transmission data signals, respectively, where N represents an integer greater than one, said device carrying out transmission of a transmission signal in response to the transmission data signals and comprising:

a baseband processing circuit comprising baseband signal producing sections, N in number, connected to said input terminals, respectively, and a baseband signal combining section;

a carrier oscillation circuit for producing a carrier signal;

a modulation circuit;

an amplifier comprising a distributing circuit, power amplifying circuits, M in number, and a combining circuit, where M represents another integer greater than one; and

a control section;

each of said baseband signal producing sections producing, as a baseband signal, a processed signal by subjecting a predetermined processing to said transmission data signal;

said baseband signal combining section being connected to said baseband signal producing sections for combining the baseband signals into a combined baseband

BNSDOCID: <GB 2315622A 1 >

signal;

said modulation circuit being connected to said carrier oscillation circuit and said baseband signal combining section for modulating said carrier signal in response to said combined baseband signal to produce a modulation signal;

said distributing circuit being connected to said modulation circuit and to said power amplifying circuits for distributing said modulation signal into distributed modulation signals to deliver said distributed modulation signals to said power amplifying circuits, respectively;

each of said power amplifying circuits amplifying said distributed modulation signal to produce an amplified signal, each said power amplifying circuit producing an alarm signal when a failure occurs therein;

said combining circuit being connected to said power amplifying circuits for combining the amplified signals to produce said transmission signal;

said control section being connected to said power amplifying circuits and said baseband signal producing sections for controlling said baseband signal producing sections in response to a said alarm signal or signals to increase the level of said combined baseband signal so as to compensate for a decrease in the power of said transmission due to said failure or failures.

4. A transmission device as claimed in Claim 3, wherein said control section comprises:

decreased power calculating means connected to said power amplifying circuits for calculating as a decreased power, in response to the alarm signal from each of said power amplifying circuits, the decrease in power of said transmission singal due to said failure occurred in each of said power amplifying circuits; and

controlling means connected to said decreased power calculating means and said baseband signal producing sections for controlling said baseband signal producing sections to increase the level of said combined baseband signal so as to compensate for said decreased power.

5. A transmission device as claimed in Claim 4, wherein said decreased power calculating means comprises:

detecting means connected to said power amplifying circuits for detecting, in response to the alarm signal from each of said power amplifying circuits, the number m of erroneous power amplifying circuits in which said failure occurs among said power amplifying circuits; and

calculating means connected to said detecting means for calculating said decreased power in response to the number m of said erroneous power amplifying circuits.

6. A transmission device as claimed in Claim 4, wherein said controlling means comprises:

RNSDOCID: <GB 2315622A I >

calculating means connected to said decreased power calculating means for calculating, in response to said decreased power by the use of a relationship represented by $10 \times \log(n \times p) = 10 \times \log(N \times p) - L$, the number n of baseband signal producing sections which should be turned off among said N baseband signal producing sections, where said deceased power is represented by L (dB) and where each of said power amplifying circuits produces the amplified signal p(W) when each of said power amplifying circuits is normally operated without occurrence of said failure;

turning-off means connected to said calculating means for turning off n baseband signal producing sections among said N baseband signal producing sections; and

increasing means connected to said turning-off means for increasing each of output levels of (N - n) remaining baseband signal producing sections so that the level of said combined baseband signal is increased by L (dB).

7. A transmission device as claimed in Claim 3, wherein each of said baseband signal producing sections produces, as said baseband signal, said processed signal given by subjecting, as said predetermined processing, a coding processing to said transmission data signal.

8. A transmission device as claimed in Claim 3, wherein each of said baseband signal producing sections produces, as said baseband signal, said processed signal

given by subjecting, as said predetermin d processing, a spread spectrum processing to said transmission data signal.

9. A transmission device which is for use in a base station of a mobile communication system in carrying out transmission of a transmission signal and which comprises:

first through Q-th baseband processing circuits, each of which comprises baseband signal producing sections, N in number, and a baseband signal combining section, where Q represents an integer greater than one and where N representing another integer greater than one;

first through Q-th carrier oscillation circuits for producing first through Q-th carrier signals of carrier frequencies different from each other, respectively;

first through Q-th modulation circuits;

a modulation signal combining circuit;

an amplifier comprising a distributing circuit, power amplifying circuits, M in number, and a combining circuit, where M represents still another integer greater than one; and

a control section;

each of said baseband signal producing sections of each of said first through said Q-th baseband processing circuits producing, as a baseband signal, a processed signal given by subjecting a predetermined

BNSDOCID: <GB___2315622A_I_>

processing to a transmission data signal;

said baseband signal combining section of each of said first through said Q-th baseband processing circuits combining the baseband signals of the baseband signal producing sections of each of said first through said Q-th baseband processing circuits into a combined baseband signal;

said first through said Q-th modulation circuits modulating said first through said Q-th carrier signals in response to the combined baseband signals of the baseband signal combining sections of said first through said Q-th baseband processing circuits to produce first through Q-th modulation signals, respectively;

said modulation signal combining circuit combining said first through said Q-th modulation signals into a combined modulation signal;

the distributing circuit of said amplifier distributing said combined modulation signal into distributed modulation signals to deliver said distributed modulation signals to the first through the M-th power amplifying circuits of said amplifier, respectively;

each of said power amplifying circuits amplifying said distributed modulation signal to produce an amplified signal, each of said power amplifying circuits producing an alarm signal when a failure occurs therein;

the combining circuit of said amplifier combining th amplified signals of said first through said M-th power amplifying circuits to produce said transmission signal;

said control section controlling the baseband signal producing sections of each of said first through said Q-th baseband processing circuits in response to the alarm signal or signals to increase a level of said combined baseband signal of each of said first through said Q-th baseband processing circuits so as to compensate for a decrease in power of said transmission signal due to said failure or failures.

10. A transmission device as claimed in Claim 9, wherein said control section comprises:

decreased power calculating means connected to said power amplifying circuits for calculating as a decreased power, in response to the alarm signal from each of said power amplifying circuits, the decrease in power of said transmission singal due to said failure occurred in each of said power amplifying circuits; and

controlling means connected to said decreased power calculating means and the baseband signal producing sections of each of said first through said Q-th baseband processing circuits for controlling the baseband signal producing sections of each of said first through said Q-th bas band processing circuits to incr ase the level of said combined baseband signal of each of said first

BNSDOCID: <GB 2315622A I >

through said Q-th bas band processing circuits so as to compensate for said decreased power.

11. A transmission device as claimed in Claim 10, wherein said decreased power calculating means comprises:

detecting means connected to said power amplifying circuits for detecting, in response to the alarm signal from each of said power amplifying circuits, the number m of erroneous power amplifying circuits in which said failure occurs among said power amplifying circuits; and

calculating means connected to said detecting means for calculating said decreased power in response to the number m of said erroneous power amplifying circuits.

12. A transmission device as claimed in Claim 10, wherein said controlling means comprises:

calculating means connected to said decreased power calculating means for calculating, in response to said decreased power by the use of a relationship represented by $10 \times \log(n \times p) = 10 \times \log(N \times p) - L$, the number n of baseband signal producing sections which should be turned off among the N baseband signal producing sections of each of said first through said Q-th baseband processing circuits, where said deceased power is represented by L (dB) and where each of said power amplifying circuits produces the amplified signal p(W) when each of said power amplifying circuits is normally op rated without occurrence of said failure;

turning-off means connected to said calculating means for turning off n baseband signal producing sections among the N baseband signal producing sections of each of said first through said Q-th baseband processing circuits; and

increasing means connected to said turning-off means for increasing each of output levels of (N - n) remaining baseband signal producing sections of each of said first through said Q-th baseband processing circuits so that the level of the combined baseband signal of each of said first through said Q-th baseband processing circuits is increased by L (dB).

13. A transmission device as claimed in Claim 9, wherein each of said baseband signal producing sections produces, as said baseband signal, said processed signal given by subjecting, as said predetermined processing, a coding processing to said transmission data signal.

14. A transmission device substantially as herein described with reference to figures 2, 3 or 4 of the accompanying drawings.

15. A mobile communication system employing a base station having a transmission device as claimed in any of claims 2 to 12.

BNSDOCID: <GB 2315622A I >

The Patent Office

44

Application N :	GB 9715566.7	**Examiner:**	D. Midgley
Claims searched:	1-15	**Date of search:**	3 October 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H3G GPA ,GPE,GPXX,GCX

Int Cl (Ed.6): H03G 3/20 H04B 1/04,1/74

Other: ONLINE:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.